Department for Environment Food & Rural Affairs

Report on measures for 2020 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007)

December 2022

This publication is available at www.gov.uk/government/publications

Any enquiries regarding this publication should be sent to us at

Air Quality and Industrial Emissions
Department for Environment, Food and Rural Affairs
Ground Floor, Seacole Building
2 Marsham Street
London, SW1P 4DF

Email: air.quality@defra.gov.uk

With technical input from Ricardo Energy & Environment

www.gov.uk/defra

Contents

1. Introduction

1.1 Context

Under the Air Quality Standards Regulations 2010[1], the target value (TV) for nickel (Ni) is an annual mean concentration of 20 nanograms (one billionth of a gram (10^{-9})) per cubic metre (m^{-3}) of ambient air or lower. The regulation requires the UK to report on measures in place to address the exceedance of the TV and that all reasonable measures that do not entail disproportionate cost should be taken to ensure this target is not exceeded. Nickel emissions have reduced significantly from 1990 to 2001, after which the reported emissions have either reached a plateau or fallen steadily depending on the location, reflecting the effect of environmental regulation and Best Available Techniques (BAT) for pollution control. In 2020 for the UK, data shows that there is a continuing, downward trend in emissions of Ni, which is reflected by ambient-air measurements both nationally and locally (see Table 2 of this report).

Exceedance of the TV was reported in 2014, 2016, 2018 and 2019 in the Sheffield Urban Area and reports on measures were published detailing the exceedance and the measures in place[2].

This document reports the progress in reducing emissions, together with the exceedance situation for 2020, reflecting the more recent assessment and updating the 2014, 2016, 2018 and 2019 report on measures.

1.2 Status of zone

This is the report on measures required for exceedances of the TV for Ni within the Sheffield Urban Area agglomeration zone identified within the 2020 UK air quality assessment. Exceedances within this zone were identified on the basis of model results. Fine scale modelling on a 50 m x 50 m grid resolution located around an identified industrial source was used to identify this exceedance. This exceedance was reported via e-Reporting dataflow G[3] on attainment for the compliance assessment in 2020 and Air Pollution in the UK[4].

Table 1 summarises the spatial extent and associated resident population for the exceedances identified in this zone, as reported via e-Reporting.

---

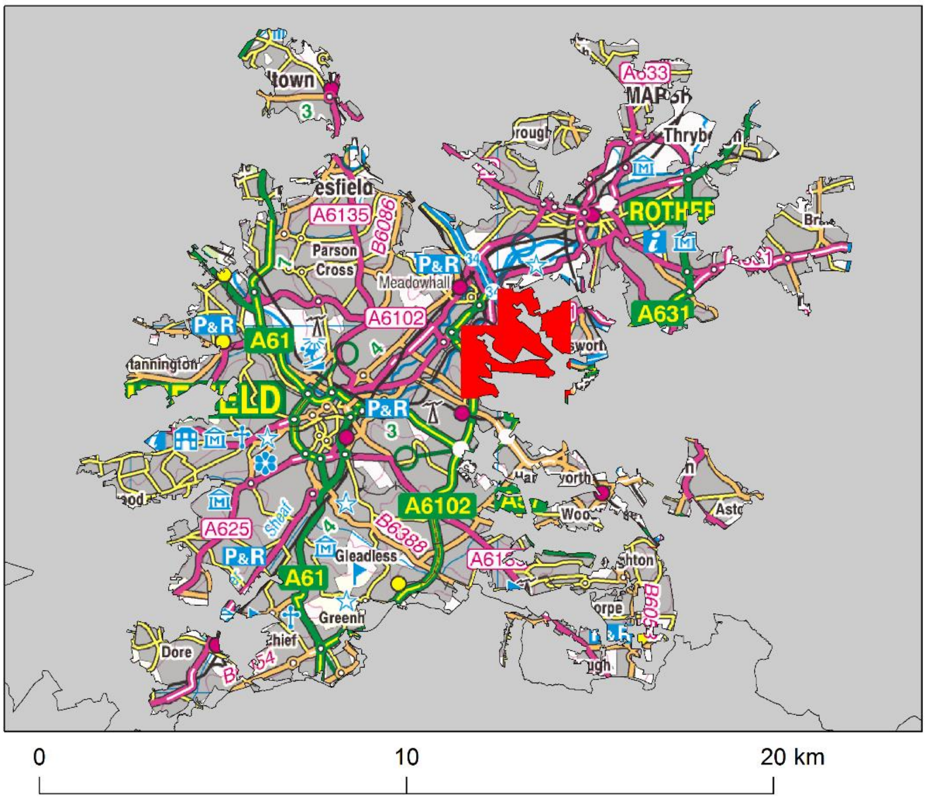
[1] The Air Quality Standards Regulations 2010 (legislation.gov.uk)
[2] https://uk-air.defra.gov.uk/library/bap-nickel-measures
[3] https://uk-air.defra.gov.uk/data/compliance-xml-files
[4] http://uk-air.defra.gov.uk/library/annualreport/index

Table 1. Area exceeding Ni target value in 2020 and associated resident population for exceeding areas within Sheffield Urban Area zone UK0007.

Zone code	Zone Name	Area exceeding TV (km^2)	Population exceeding TV
UK0007	Sheffield Urban Area	5	7409

Figure 1 shows the locations of the exceedances in the context of the zone as a whole.

Figure 1. Location of exceedance of the Ni target value in 2020 in Sheffield Urban Area zone UK0007. Areas of the zone in exceeding grid squares are marked in red.



An initial source apportionment was carried out and this analysis identified one exceedance situation within this zone related to industrial emissions:

- Sheffield [Ni_UK0007_2020_1] related to industrial emissions (area of exceedance: 5 km^2)

This report describes the exceedance situation in the zone. The sections below include a description of the exceedance situation, including maps, information on source apportionment and a list of measures already taken, ongoing or to be taken.

2 Exceedance situation Sheffield [Ni_UK0007_2020_1] related to industrial emissions

2.1 Description of exceedance

This exceedance situation is an area of exceedance of 5 km^2 and is located in the valley of the river Don to the Northeast of Sheffield City Centre in the Sheffield Urban area agglomeration zone. The exceedance was reported on the basis of the modelling assessment. The resident population associated with this exceedance situation is 7,409. This exceedance situation is adjacent to and shares common sources with the exceedance situation for Yorkshire and Humberside [Ni_UK0034_2020_1].

Table 2 lists measured annual mean concentrations of Ni from monitoring sites in Sheffield Urban Area agglomeration zone from 2004-2021, and Figure 2 indicates the location of measurement sites. The measured concentration at Sheffield Tinsley (GB0538A) in 2020 was compliant. Figure 3 shows the location of the exceedance situation in detail. The concentration of Ni at the other monitoring station within the Sheffield Urban Area agglomeration zone was also below the TV in 2020 and no other exceedances have been reported during the 2004-2021 period apart from the measured exceedances reported for 2014 and 2016 and modelled exceedances for 2018, 2019 and 2020.

The measured annual mean concentration of Ni at Sheffield Tinsley (GB0538A) in 2021 was 14 ngm^{-3} (99% data capture).

Figure 2: Location of monitoring sites in Sheffield Urban Area.

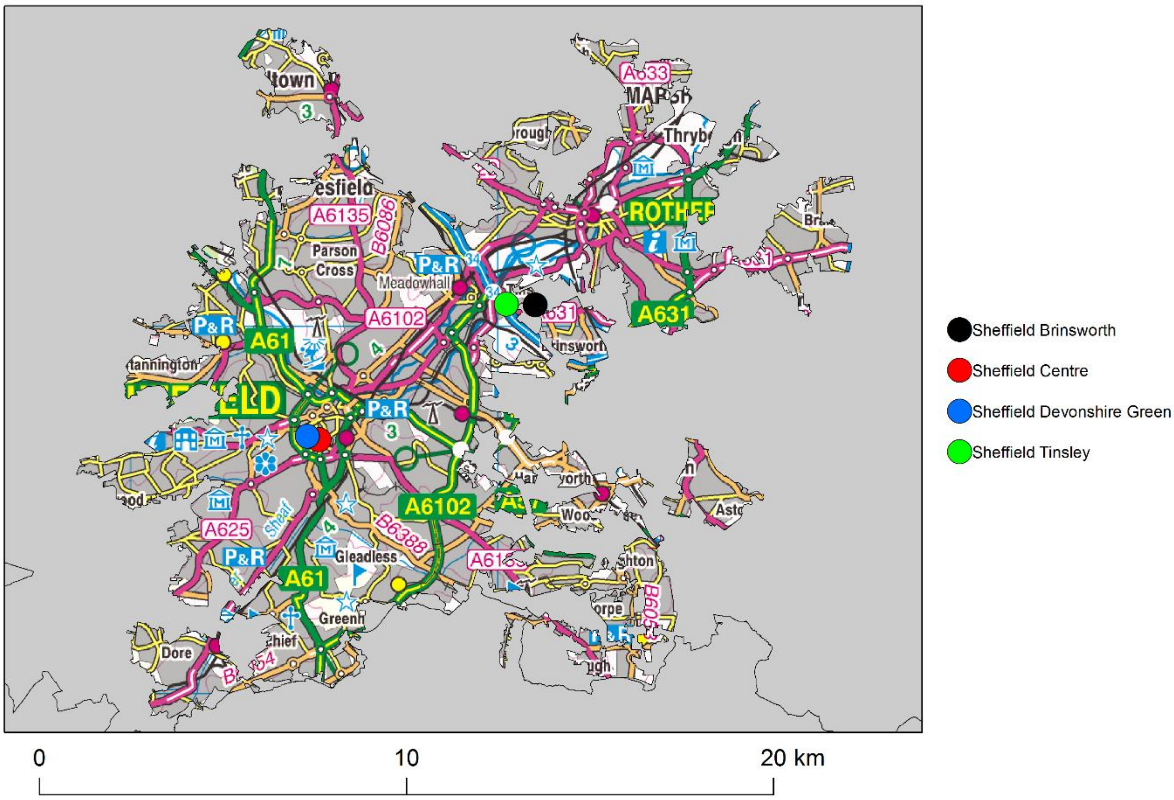


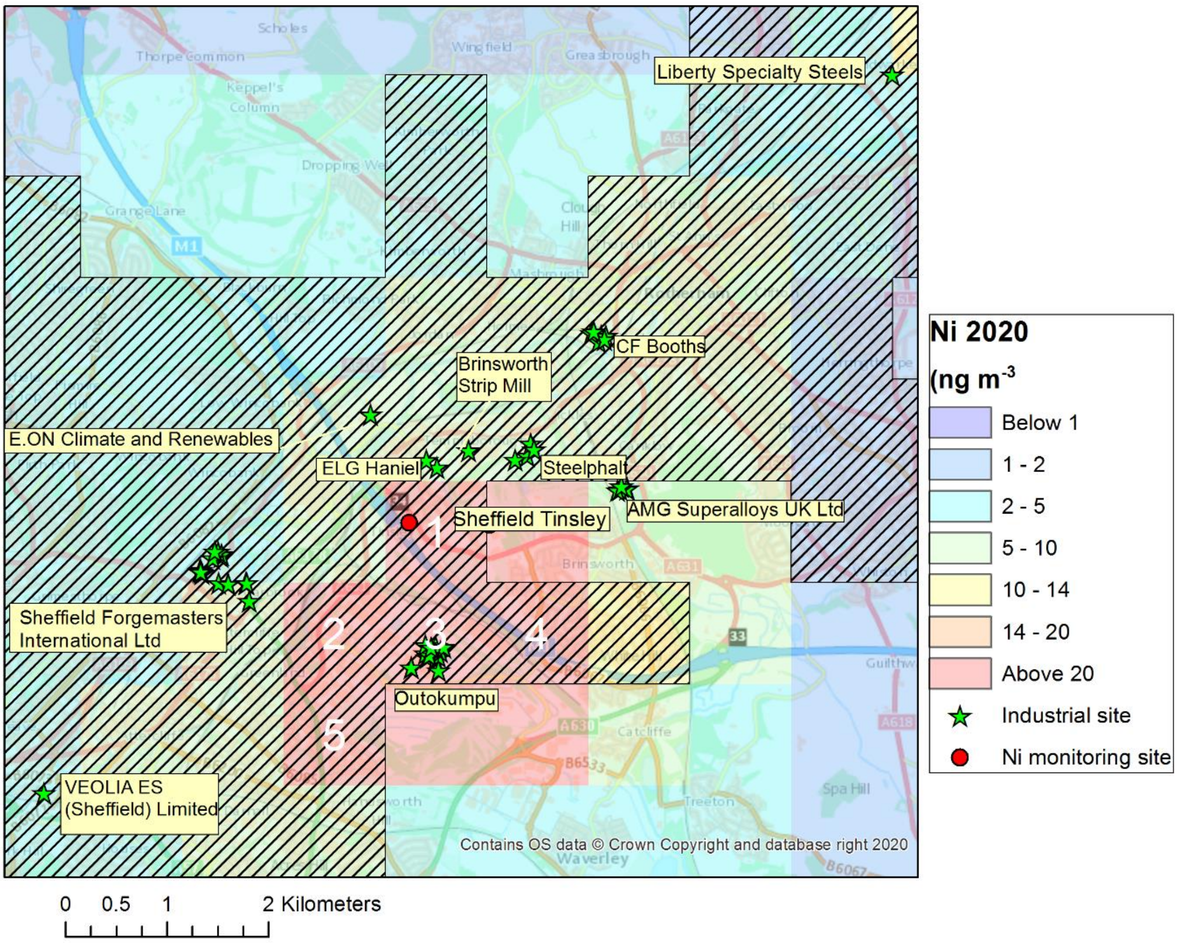
Table 2. Measured annual mean Ni concentrations in the Sheffield Urban Area UK0007 from 2004 to 2021 (ngm^{-3}). Percentage data capture is shown in parentheses.

Station (EoI code)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Sheffield Brinsworth (GB0792A)	20*	14*	12 (98)	11 (100)	12 (94)	9.8 (96)	15 (98)	15 (98)	13 (100)	13 (70)								
Sheffield Centre (GB0615A)					2 (92)	1.7 (98)	2.5 (98)	2.2 (91)	2.6 (88)	3.2 (66)								
Sheffield Devonshire Green (GB1027A)										0.86 (11)	2.6 (99)	1.9 (100)	2.7 (98)	1.7 (100)	2.2 (100)	1.8 (100)	1.7 (100)	2.2 (100)
Sheffield Tinsley (GB0538A)										14 (81)	21 (96)	18 (94)	24 (89)	17 (99)	20 (100)	15 (100)	11 (100)	14 (99)

* Data capture not available

Figure 3 shows the exceedance situation Ni_UK0007_2020_1 in detail. The figure indicates the location of the measured and modelled exceedances. In addition, the figure presents the results of national modelling on a 1 km x 1 km grid resolution that were produced for the supplementary assessment for the compliance assessment. Zone boundaries for the 1 km model grid used to assign exceedance situations and associated populations are presented as black hatching. Figure 3 shows the location of several industrial sites located close to Sheffield Tinsley monitoring station.

Figure 3. Exceedance situation Sheffield [Ni_UK0007_2020_1]. Sheffield Tinsley monitoring station is marked in red. Locations of local industrial sites are also shown. Non-hatched grid squares are assigned to the Yorkshire and Humberside zone UK0034. Note that multiple emissions sources are indicated on the map for some industrial sites (Outokumpu, Sheffield Forgemasters International Ltd, AMG Superalloys UK Ltd, E.L.G. Haniel Metals Limited, Harsco Metals Group Limited (Steelphalt), and CF Booths Limited).



2.2 Source apportionment

Modelling has been used to determine the annual mean Ni source apportionment for the exceedance situation. National modelling on a 1 km x 1 km grid resolution apportions the Ni concentration to regional and urban background sources. Additional fine scale modelling has also been carried out in support of the 2020 UK air quality assessment and this Report on Measures to characterise local industrial emissions, this is described in Appendix A1.

Table 3 provides a breakdown of the main emission sources (source apportionment) that have contributed to the grid squares of the modelled exceedances. The penultimate column is the total concentration from all emissions sources. The total concentrations are presented rounded to integers for consistency with the values reported in the compliance assessment. The values in the other columns have been rounded to two decimal places. The other shaded columns are the subtotals for the regional, urban background and local contributions.

Table 3 identifies that local emissions from industrial sources are the most significant source of Ni. Table 4 gives a more detailed source apportionment for the industry sector based on the fine scale modelling study presented in Appendix A1. Table 4 shows the contribution from the Outokumpu site for each grid square where there was an exceedance. For all grid squares the largest contribution came from the Outokumpu site.

The source apportionment presented here has been informed by the fine scale modelling carried out in support of the 2020 UK air quality assessment that was reported in September 2021.

Table 3. Source apportionment for exceedance situation Ni_UK0007_2020_1. Annual mean Ni concentration (ngm^{-3}).

Grid Square Number	OS easting (m)	OS Northing (m)	Zone	**a) Regional background: Total**	**b) Urban background increment: Total**	Urban background increment: Traffic	Urban background increment: Industry including heat and power production	Urban background increment: commercial and residential	Urban background increment: Shipping	Urban background increment: Off road mobile machinery	Urban background increment: Other	**c) Local increment: Total**	Local increment: Industry including heat and power production	**Total for all emissions sources (a+b+c)**	Resident population
1	440500	390500	7	0.52	1.90	0.17	1.26	0.35	0.00	0.10	0.02	21.34	21.34	24	2583
2	439500	389500	7	0.45	1.73	0.13	1.11	0.32	0.00	0.14	0.02	26.43	26.43	29	149
3	440500	389500	7	0.45	1.36	0.14	0.84	0.29	0.00	0.08	0.02	119.41	119.41	121	0
4	441500	389500	7	0.52	1.25	0.17	0.69	0.32	0.00	0.06	0.02	25.89	25.89	28	2243
5	439500	388500	7	0.40	1.50	0.13	0.85	0.37	0.00	0.13	0.02	24.16	24.16	26	2434

Table 4. Detailed source apportionment for industrial sources only for exceedance situation Sheffield [Ni_UK0007_2020_1]. Annual mean Ni concentration (ngm^{-3}).

Grid Square Number	OS easting (m)	OS Northing (m)	Zone	Outokumpu	**Local increment: Industry including heat and power production**
1	440500	390500	7	21.34	21.34
2	439500	389500	7	26.43	26.43
3	440500	389500	7	119.41	119.41
4	441500	389500	7	25.89	25.89
5	439500	388500	7	24.16	24.16

2.3 Measures

Improving air quality is a high priority for the Government, that published the Clean Air Strategy in January 2019, which sets out new and ambitious goals. An exceedance in this zone was reported in 2014, 2016, 2018 and in 2019, but not in other years since the TV came into force, including 2017. The Government takes any exceedance seriously whilst ensuring that any measures put in place are proportionate to the exceedance. The Government has brought together the regulators and local industrial operators with emissions of Ni to air in pursuit of this aim. Meetings have enabled:

- the Government to communicate to the industrial regulators and operators the extent of the issue and the seriousness with which it is taken;
- the regulators to demonstrate that the operators are applying all cost-effective measures, and in particular are applying best available techniques as required by The Environmental Permitting Regulations (England & Wales), which aim to prevent or minimise pollution by placing stringent limits on emissions from industrial sources.
- the operators to cooperate and share best practice in managing their operations; and
- the development of the latest evidence in understanding the predominant sources.

Work thus far undertaken has included fine scale modelling (Appendix 1) to model the impact of known emissions to the measurements at Tinsley Monitoring Station and daily and hourly monitoring campaigns at the Tinsley Monitoring station to obtain greater temporal resolution as regards the measurements made at the site (Appendix 2).

Table 5 summarises measures taken or to be taken at local industrial sites identified that may contribute to nickel in ambient air.

In the future, the regulator will continue to engage with local operators to minimise nickel emissions. It is planned to hold regular inspection visits scheduled to verify that the above measures remain implemented. Efficiency of the already implemented measures will be reviewed on a regular basis and opportunities for further improvements will be discussed.

Table 5. Table of measures taken or to be taken at local industrial sites.

Measure code	Measure Description	Classification	Implementation dates		Other information		Comment
ELG Haniel Metals Ltd_1	Purchase of shearing machine (@£400K)	Air Quality Planning and Policy Guidance	Start:	Dec 2018	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** The shearing machine was commissioned in December 2018 and has proved highly efficient resulting in the decommissioning of one of the two oxy-propane cutting stations. The reduction in oxy-propane cutting on site was around 75%. This has resulted in a reduction in fugitive emissions (including particulate matter/nickel)
			Expected end:	N/A			
ELG Haniel Metals Ltd_2	Installation of plasma cutting booth with ventilation and filtration system (@11K)	Air Quality Planning and Policy Guidance	Start:	June 2018	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** Plasma cutting is now only carried out in a booth with ventilation and filtration system resulting in a reduction in fugitive emissions.
			Expected end:	N/A			

ELG Haniel Metals Ltd_3	Monitoring of Densifier Unit by a MCERTS certified monitoring contractor (£2K)	Air Quality Planning and Policy Guidance	Start:	June 2018	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** Monitoring completed. Fugitive releases from the densifier building open doorway contain varying quantities of dust / nickel.
			Expected end:	October 2018			
ELG Haniel Metals Ltd_4	Monitoring of the oxy-propane cutting station (£2K)	Air Quality Planning and Policy Guidance	Start:	June 2018	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** Monitoring completed. Fugitive releases from oxy-propane cutting, as expected, contain varying quantities of nickel. Therefore, reduction plan formulated (including the purchase of shearing machine).
			Expected end:	October 2018			
ELG Haniel Metals Ltd_5	Installation of guillotine sheer (@80K)	Air Quality Planning and Policy Guidance	Start:	April 2020	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** Guillotine shear successfully commissioned. Since its installation there has been very little requirement for plasma

			Expected end:	N/A			cutting on site although the process is still required at times.
ELG Haniel Metals Ltd_6	Installation of PVC curtain on densifier building open doorway (@£8K)	Air Quality Planning and Policy Guidance	Start:	April 2020	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** This has been installed in 2020. PVC strip curtains form an effective barrier against dust and airborne contamination.
			Expected end:	N/A			
ELG Haniel Metals Ltd_7	Monitoring of the oxy-propane cutting station	Air Quality Planning and Policy Guidance	Start:	June 2018	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** Records are kept when oxy-propane cutting is carried out on site.
			Expected end:	N/A			

ELG Haniel Metals Ltd_8	Reduction of scrap handling volumes	Air Quality Planning and Policy Guidance	Start:	2020	Source affected:	Waste Processing (stainless steel and non-ferrous metals)	**Task completed.** The business model for scrap management at ELG has changed. Rather than purchasing large stock in advance, material is purchased centrally and dispatched to local processing site – like Sheffield's – when required. As a result, the amount of scrap coming on site has dropped significantly and emissions from scrap processing has also reduced accordingly.
			Expected end:	N/A			
Outokumpu SMACC_1	Installation of a new oxy-fuel burner system on the electric arc furnace (£900K)	Air Quality Planning and Policy Guidance	Start:	August 2018	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** Oxy fuel burners installed in the EAF to improve the speed and efficiency of melting. The ability to close the slag door benefits the capture efficiency of the furnace extraction system leading to a reduction in fugitive emissions from the melt shop roof.
			Expected end:	N/A			

Outokumpu SMACC_2	Operator to undertake modelling of the emissions from site to determine whether or not the data collated by Kings College London accounted for all emissions from site or just point sources (£2K)	Air Quality Planning and Policy Guidance	Start:	June 2018	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** A modelling study was carried out in 2019. The contributions from the known sources were estimated to account for up to 48 % of the measured values for the whole of 2017. The gap between the modelled values and the contribution estimated by King's College over the course of the study equates to 12% or 2.94 ng/m³, which can be assumed to be emitted from unknown fugitive sources such as stockyards.
			Expected end:	N/A			
Outokumpu SMACC_3	Operator to carry out a dust and PM_{10} monitoring and characterisation assessment for the steel works to investigate the concentrations of nickel and other materials potentially migrating off site *(Ref Doc. DS/AG/Outokumpu/01*) (£26K)	Air Quality Planning and Policy Guidance	Start:	April 2018	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** A diffuse dust emission apportionment study was carried out in 2019. Combined directional and depositional dust monitoring gauges were installed at four onsite locations. Monitoring was carried out over a six-month period and a selection of samples analysed to determine the elemental composition. Modelling was then carried out to investigate the proportion of emissions associated with area sources.
			Expected end:	October 2018			

							Model results suggested that the raw materials reception and stockyard areas had the highest potential fugitive PM10 emissions. As a result, the operator has implemented additional dust suppressions measures (see action ref. SMACC_8).
Outokumpu SMACC_4	Operator to define measurement/monitoring programme for fugitive roof emissions.	Air Quality Planning and Policy Guidance	Start:	May 2018	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** Dust and fume from the melting shop are collected by an extraction system within the melting shop building, but from time to time there may be spillages from the system that are emitted from the building ridge vents. The mass emission of these releases was first measured in 1996, and then again in 2001, 2006 and 2007, the latter two occasions before and after modifications to the geometry of the melting shop building to minimise such releases. In order to confirm that mass emission levels had not altered significantly since 2007, measurements were repeated in early 2019.
			Expected end:	N/A			

Outokumpu SMACC_5	Operator to carry out measurements as defined in the above monitoring programme for fugitive emissions (10-20K)	Air Quality Planning and Policy Guidance	Start: Expected end	October 2018 N/A	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** The estimated 2019 annual mass emission from the roof vents was found to be almost identical to the result from 2007, confirming that estimations used in the impact assessment were sound.
Outokumpu SMACC_6	AOD Fume Hood - scheduled maintenance (£120K)	Air Quality Planning and Policy Guidance	Start: Expected end:	2018 N/A	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** This capital scheme was completed at summer shutdown 2018 (end July / beginning August). Since this time, they have spent a further £400k on ductwork improvements. AOD Fume Hood Replacement have led to a reduction in fugitive emissions from the melt shop roof
Outokumpu SMACC_7	Refurbishment of main air fan in the Melt Shop - Scheduled Maintenance (£70K)	Air Quality Planning and Policy Guidance	Start: Expected end:	2018 N/A	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** This capital scheme was completed at summer shutdown 2018 (end July / beginning August). Since this time, they have spent a further £300k on fan refurbishments. Refurbishment of main air fan to increase efficiency of extraction in

							the Melt Shop have led to a reduction in fugitive emissions from the melt shop roof.
Outokumpu SMACC_8	Targeted dust suppression on the raw materials stockyards (£100k/year)	Air Quality Planning and Policy Guidance	Start:	2020	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Task completed.** The dust source apportionment study (see action ref. SMACC_3) identified that the raw materials reception and stockyard areas had the highest potential fugitive emissions. Emissions from these areas may be due to vehicle movements and wind-whip from stockpiles and exposed surfaces, including re-suspension of dust on haul routes. As a result, the operator has developed and implemented a risk assessment tool based on a three-day weather forecast. The tool highlights when rainfall, temperature, wind speed and wind direction are likely to have an adverse effect on the contribution of the stockyard activities on ambient levels in Tinsley, redirecting targeted bowser and sweeping activities accordingly.
			End:	N/A			

Outokumpu SMACC_9	Improvements to the primary extraction and to the AAF bag filter plant (£700k in 2020)	Air Quality Planning and Policy Guidance	Start:	2021	Source affected:	Stainless steel slab, bloom, billet and cast ingot production	**Ongoing.** Studies have shown that nickel emission are predominantly (over 80%) emitted from stationary sources including from the AAF ridge vents and the melt shop roof. The site uses Best Available Technology (BAT) to control its emissions and use of a filter bag plant for abatement. Particulate emissions from the bag plant are typically around half of the 5mg/m3 emission limit value (ELV). The ELV is usually complied with, but some days exceedances can be experienced. To improve the performance of the bag plant, the following measures have been implemented: - An engineer has been appointed as reliability engineer to specifically work on the AAF and the DC Arc - The maintenance shift has been increased leading to an improved response time to deal with issues with the bag plant
			End:	N/A			

							- A diagnostic system has been developed to optimise plant performance. This has successfully helped alleviate acute issues. There are plans to develop the system further to improve the detection of chronic issues using statistical tools - Major maintenance and CapEx on the bag plant
Sheffield Forgemasters International Limited_1	Installation of new Forge Burning extraction (@500K)	Air Quality Planning and Policy Guidance	Start: Expected end:	August 2018 N/A	Source affected:	Steel Processing	**Task completed.** The Forge Burning Booth and extraction has been replaced in 2018 as scheduled. This has resulted in much improved capture of particulates from the burning process and prevention of fugitive emissions from the booth itself. It is estimated that annual emissions of nickel from the burning process have been reduced from 4.89kg to 2.6kg.

Sheffield Forgemasters International Limited_2	Improvements to the bag filter plant	Air Quality Planning and Policy Guidance	Start: Expected end:	August 2020 N/A	Source affected:	Steel Processing	**Task completed.** Improvements have been made to the EAF dust handling system. Bags are now filled from individual hoppers rather than a conveyor system. This has reduced fugitive emissions from this process.

2.4 Modelling

Appendix A1 presents fine scale modelling that has identified the emissions sources as potential contributors to the concentrations measured at Sheffield Tinsley monitoring station.

2.5 Monitoring

The Report on Measures for 2014 and 2016 exceedances of the Target Value for Nickel in Sheffield[5] reported the outputs of a daily heavy metals monitoring campaign at Sheffield Tinsley monitoring station over the period from 25th February 2016 to 9th August 2016. Analysis of measured metal concentrations was undertaken to provide measurement-based evidence to identify emission sources contributing to Nickel concentrations measured in the Tinsley area. This study identified contributions to the measured concentration from sources to the South and sources to Northeast. The source to the South was consistent with emissions from the Outokumpu site, but the sources to the Northeast were not identified. The study identified that monitoring to a higher time resolution might provide further insight into dominant sources.

During 2017 King's College London were commissioned to undertake a ten-week high time resolution (hourly) measurement campaign. This campaign took place January and March 2017 with the aim of providing further evidence to identify sources of Ni measured at the Tinsley AURN site. This work identified two sources of Nickel: one related to point source emissions which was characterised by molybdenum and manganese and one fugitive source type, characterised by chromium and calcium, likely to be associated with material handling or transport.

Wind speed and direction measurements were used to quantify where these source types were emitted from. There were three broad source directions –East, West, and South. The source from the South, which contributed 47% to the Nickel concentrations measured during the study, was associated with emissions from the Outokumpu facility. This contribution was associated mainly with point source type emissions of Nickel, with a smaller contribution from fugitive source type emissions.

[5] Report on measures for 2014 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2014.pdf Report on measures for 2016 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2016.pdf

The source to the East contributed 40% to the measured Nickel concentrations and was related mainly to industrial sources to the Northeast. The source from the West represented emissions from over half of the industries in Sheffield, which lie in that direction and was dominated by the point source type emissions. The sources to the West provided the smallest contribution to measured Ni concentrations.

The widespread nature of point source emissions across industries in Sheffield makes this challenging to tackle. However, the high time resolution measurements help to focus resources and identify specific emissions from industrial sources.

3. Industrial Sources of Nickel

3.1 Environment Agency Regulated Plant Part A

Further information about operating processes at individual regulated plant can be found in Appendix A1. From the industrial sites identified to date, Outokumpu has been identified as making the most significant contribution from regulated industry to the levels of Ni measured at Tinsley monitoring site. Outokumpu is regulated by the Environment Agency and is declared as using BAT. Ongoing further analysis of emissions samples from the area is being undertaken, in conjunction with Outokumpu to assist in identification of other potential sources of fugitive emissions that are currently unidentified. Actions to tackle Nickel emissions from Outokumpu are presented in Table 5.

3.2 Local Authority Regulated Plant Part B

Further information about operating processes at individual sites can be found in Appendix A1. The Local Authority has advised that these are all operating within the terms and conditions of their permits.

3.3 Unregulated plant – Local Authority

Sheffield City Council has provided information that none of the other industrial sites identified as potential contributors to Ni emissions in the region fall within the scope of the regulations and as such there are no relevant measures to put forward.

A1. Local scale modelling of the industrial point sources

This annex summarises supplementary modelling work carried out to investigate the sources of the measured exceedance of the Air Quality Standards Regulations (AQSR) 2010 annual mean target value (TV) for nickel (Ni) of 20 ng m^{-3} at the Sheffield Tinsley monitoring station for the year 2020. Under AQSR, the UK is required to identify zones and agglomerations where exceedances of the TV occur. Exceedance of the TV triggers a requirement within the regulation to prepare a report on measures.

Source identification is not a formal requirement for this report on measures but is clearly a prerequisite for demonstrating that all measures not entailing disproportionate costs have been taken, and modelling can be useful to evaluate source contributions.

In the 2016 Report on Measures[6] a review of the following sources of information were used to compile a list of the potential sources of Ni relevant to this exceedance:

- a review of the results from high time resolution monitoring campaigns at the Sheffield Tinsley monitoring station
- sources present in the National Atmospheric Emissions Inventory (NAEI) and Pollution Climate Mapping (PCM) national modelling
- sources identified by the Environment Agency (EA), Sheffield City Council (SCC) and Rotherham Metropolitan Borough Council (RMBC).

This annex also describes the modelling approach and model results, including concentration maps, comparison of the model output with observations, modelled source apportionment and compliance situation as modelled. It concludes with recommendations for further work to build on the output of this modelling study to further improve understanding of the Sheffield Ni TV exceedance reported in 2020.

---

[6] Report on measures for 2016 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2016.pdf

A1.1. Ni emissions data and data from related studies

A1.1.1. Review of sources present in the NAEI and national modelling

The PCM modelling of Ni concentrations for 2020 serves as the background for this local study. Due to reporting timescales, the 2020 PCM compliance assessment modelling took NAEI 2019 emission estimates with projections to 2020 as input.

To support this detailed modelling, information on Ni emissions and release characteristics for the principal industrial Ni emission sources were provided by the Environment Agency (including data collated on sites regulated by Sheffield City Council and Rotherham Metropolitan Borough Council) and complemented by emissions data from the NAEI 2019. Emissions were released from 13 emission sources from one plant including 10 point and 3 line sources.

The contribution from local point sources of Ni based on the NAEI 2019 were subtracted from the national modelling in order to avoid double counting of these contributions.

A1.1.2. Review of the 2014, 2016, 2018 and 2019 studies and compilation of sources considered in the 2020 study

The previous local studies of point source contributions to Ni in Sheffield during 2014 (Brookes (2016)[7], Defra (2016)[5]), 2016 (Defra (2018)[6]), 2018 (Defra (2020)[8]) and 2019 (Defra (2021)[9]) provides a basis for the modelling approach for 2020. The information gathered for the 2014, 2016, 2018 and 2019 modelling on emissions, processes and release parameters has been combined with the emission data from the NAEI 2019, EA and local authority data to compile the input for the 2020 modelling.

---

[7] Brookes, D. and Rose, R. (2016). Local study of point source contributions to Nickel in Sheffield, 2014, Ricardo Energy & Environment.

[8] Report on measures for 2018 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2018.pdf
Report on measures for 2019 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2019.pdf

[9] Report on measures for 2019 exceedance of the Target Value for Nickel in Sheffield Urban Area agglomeration zone (UK0007), https://uk-air.defra.gov.uk/assets/documents/reports/bap-nickel-measures/ni_sheffield_UK0007_reportonmeasures_2019.pdf

Additional information was provided by the Environment Agency for the 2020 modelling. This included that Darwin Holdings closed in 2018 and Trefoil, Hambleton Steel and ELG are no longer considered to be significant Ni emitters due to improved processes that has reduced the emissions at these sites. Ni emissions data were indicated as being low and unspecified; these sites have been mapped but not modelled (see Table A1.2 and Figure A1.1). In 2019 and 2020, only the Ni emissions from the principal industrial source, Outokumpu, were modelled using the local modelling method. Ni emissions and release characteristics were provided by the Environment Agency. The emission sources that have been modelled at higher resolution in the current study are listed in Table A1.3 and mapped in Figure A1.1. Table A1.3 includes descriptions of whether emissions were treated as line (e.g. along a roof vent), point (e.g. from a chimney stack) or volume releases (e.g. diffuse emissions from a storage area or building). The bearings from the Sheffield Tinsley monitoring station to each release point have been calculated and used to relate each source to the three broad source directions identified in the K-means cluster analysis of CPF BPPs in the KCL study (Green et al., 2017)[10].

[10] “Source Apportionment of Nickel Sources at Sheffield Tinsley”; David C Green, Anna Font, Max Priestman & Anja H Tremper, Environmental Research Group, King’s College London; November 2017.

Table A1.2 – Identified Ni emitters or emission points that were not modelled due to low emissions rates or lack of information

Operator	Address	Stack Description	Emission point description	Data provider
E.L.G. Haniel Metals Limited	Sheffield Road, Tinsley, Sheffield, S9 1RT	Started Operating in 2012 - Shredding of Metal	Densifier Outfeed building – 2018 EA site report provides results of short-term monitoring (June 2018) which indicate minimal if any fugitive emissions for this emission point.	EA
Yorkshire Water Services Limited	Blackburn Meadows STW, Alsing Road, Road, Tinsley, Sheffield. S9 1HF	Prior to October 2013: Incineration of non-hazardous waste. Since March 2016: sewage sludge is anaerobically digested in a bio-energy digestion plant (BED).	Prior to October 2013 a sewage sludge incinerator operated. A composting facility was then used to process sewage sludge from 2014 to early 2016 and could have contributed diffuse Ni emissions during this period. The 2018 EA site report indicates that Ni emissions from the BED operating since March 2016 are negligible.	EA
Harsco Metals Group Limited, Steelphalt	Sheffield Road, The Ickles, Rotherham S60 1DR	EA regulated – Crushing and screening of metallurgical slag from steel works. RMBC regulated – Road stone coating activity - asphalt plant which involved the use of bitumen mixed together with varying proportions of aggregate, filler and fibre pellets to produce asphalt.	Roadstone coating plant - stack A1. 2018 EA site report indicates Ni emissions are not quantified, abatement is in place for PM emissions for which there is continuous monitoring, this shows PM emissions are significantly below the emission limit. Storage of limestone product. EA site report provides no information on Ni emissions.	EA
Sheffield Forgemasters	Sheffield Forgemasters Brightside	A1	Open roadways. Emissions from roadways are continuously abated which indicates Ni would be minimal compared to open storage areas.	EA/NAEI EA

International Ltd Hambleton Steel Limited	Hambleton Steels, Fullerton Road, Ickles, Rotherham S60 1DJ	RMBC regulated – No data.	No data.	
		A3	Forge Ingot Burning, Bag Filter and Plant Stack	
		A4	Gas Fired Boiler Plant Stack	
		A5	Gas Fired Boiler Plant Stack	
		A6	Gas Fired Boiler Plant Stack	
		A7	Gas Fired Boiler Plant Stack	
		A8	Forge Heating Furnace No.1 Stack	
		A9	Forge Heating Furnace No.7 Stack	
		A11	Heavy Forge Roof Vents (exhausts from forge furnaces2, 14, 17, 28, selas furnace and heat treatment furnaces NTP1 to 16, 18 and 20a/b)	
		A13	Foundry Shot Blast Stack	
		A15	Foundry Burning Booth Stack	
		A20	Foundry Heat Treatment Furnace Stacks	
		A21	Foundry Heat Treatment Furnace Stacks	
		A22	Foundry Heat Treatment Furnace Stacks	
		A28 (251-255)	Melting Shop Low Casting Bay Roof Vents (Furnaces 251-255)	
		A31	Forge Heating Furnace No.3 stack	
Liberty Speciality Steels	Aldwarke Lane	-	-	PCM/NAEI
VEOLIA ES (SHEFFIELD) LIMITED	Sheffield Energy Recovery Facility	Release Point A1	Main Stack	EA/NAEI
E.ON Climate and Renewables	Blackburn Meadows	Release Point A1	Main Stack	EA/NAEI

UK Biomass Ltd	Renewable Energy Plant			
AMG Superalloys UK Ltd	Fullerton Road	A1	Arc Furnace	EA/NAEI
		A2	Arc Furnace	
		Mix filter 65	Mix filter 65	
		Pangborne Shotblast	Pangborne Shotblast	
		Arc Furnace Shop Roof Vent	Arc Furnace Shop Roof Vent	EA
E.L.G. Haniel Metals Limited	Sheffield Road, Tinsley, Sheffield	Oxy-propane Cutting Area	Oxy-propane Cutting Area	EA
		Plasma Cutting Area	Plasma Cutting Area	EA
Harsco Metals Group Limited, Steelphalt	Sheffield Road, The Ickles, Rotherham	Open stockpile storage of slag	Storage of slag prior to crushing (South of crushing plant)	EA
		Open storage of crushed/screened slag	Storage of slag prior to coating (North of coating plant)	EA
		Open storage of crushed/screened slag	Storage of slag prior to coating (Southwest of coating plant)	EA
		Enclosed crushing plant	Crushing plant	EA
Liberty Speciality Steels	Sheffield Road, Rotherham	A1	Hot Mill Reheat Furnace	EA
Darwins Holdings Limited, Fitzwilliam Works	Sheffield Road, Tinsley	Roof vents, roller shutter doors etc.	Roof vents, roller shutter doors etc.	EA
Trefoil Steel Company Limited, Rotherfield Works	Dead Man's Hole Lane, Tinsley	Melting shop roof vents (release melting, tapping, and finishing emissions which vent internally)	Melting shop roof vents	EA
		Arc air cutting cartridge filter grille	Arc air cutting cartridge filter grille	EA
		DCE shotblasting cartridge filter	DCE shotblasting cartridge filter	EA

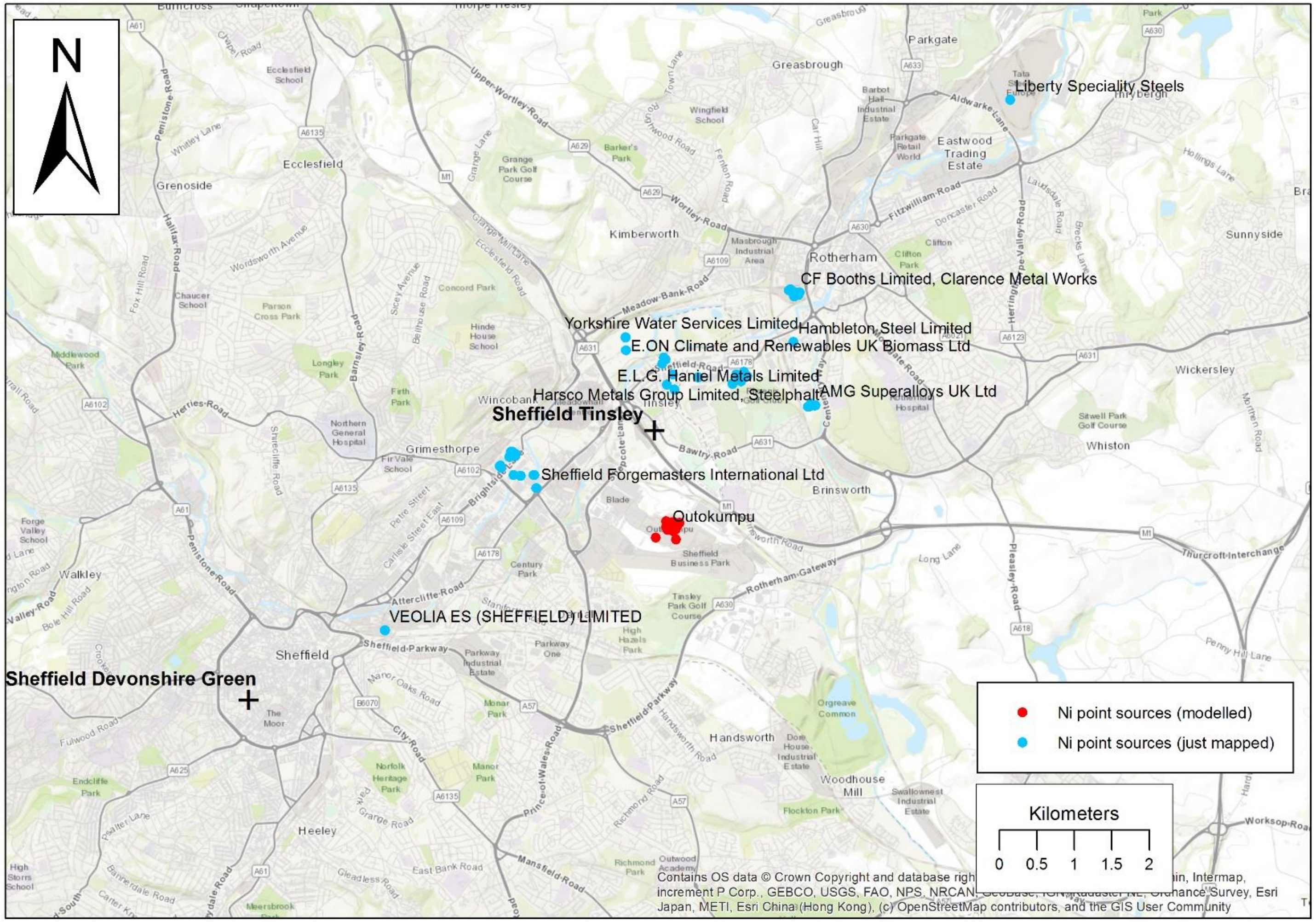
CF Booths Limited, Clarence Metal Works	Armer St, Rotherham	Decontamination units: Addax 1 (rotary gas/oil fired dryers which de-grease by volatilisation)	Addax 1	EA
		Decontamination units: Addax 2 (rotary gas/oil fired dryers which de-grease by volatilisation)	Addax 2	
		Decontamination units: C4 (gas oil fired box type batch furnaces, 1000kg capacity)	C4	
		Furnaces: F3 (gas oil heated crucible furnace <=5 t capacity)	F3	
		Furnaces: combine F1, F2, F4, F8 (electric induction furnaces), with F5 and F6 (oxy-oil fired rotary furnaces <5 t capacity)	F1, F2, F4, F8, F5 and F6	
		Furnaces: F9 and F10 (electric induction furnaces <5 t capacity)	F9 and F10	
		Combined fugitive nickel emissions for the Addax facilities and furnaces	Addax facilities and furnaces	EA
		Combined diffuse nickel emissions for Raw Materials Storage Area, road transport/Fork lift trucks/diesel cranes and mobile plant	Raw Materials Storage Area, road transport/Fork lift trucks/diesel cranes and mobile plant	EA

Table A1.3– Identified Ni emission points included in the modelling study. Emission rates are not specified for category c sources.

Operator	Site Name	Stack Name/Description	Stack Location (description)	Ni emissions, kg	Release type	Bearing to Sheffield Tinsley (°)	Temporal profile?	Categorisation for modelling (description) and KCL cluster assignment	Data provider
Outokumpu	Stainless Melting and Continuous Casting	A1	Melt Shop Bag Filter	1,380	Point	173	No	**a** (Emissions split between releases derived from 2016 and 2020 emissions from the EA.), **KCL South cluster**	EA
		A2	DC Arc Furnace	1.04	Point	173	No		
		A3	Grinder Bag Filter	9.70	Point	169	No		
		A4	Grinder Bag Filter	18.28	Point	168	No		
		A5	Grinder Bag Filter	3.93	Point	166	No		
		A6	Radial Saw Bag Filter	0.09	Point	168	No		
		A13	Cast Product cut-off Bag Filter	11.38	Point	169	No		
		A14	Grinder Bag Filter	16.44	Point	164	No		
		A15	Melting Shop Scanvenging Filter (West)	0.34	Point	179	No		

		A16	Melting Shop Scanvenging Filter (East)	0.1	Point	179	No		
		A17	EAF Dust Storage Silo Filter	0.00	Point	172	No		
		N/A	West vent melt shop roof	1,049	Point	178	No		
		N/A	East vent melt shop roof	595	Point	173	No		
		N/A	Roadways - Traffic		Volume	171	No	**c** (Modelled contribution scaled after unit emissions applied distributed over the volume of each source derived from the mapped surface area and estimated height.), **KCL South cluster**	EA
		N/A	Raw materials storage area - storage of waste dust	82.01	Area	170	No	**c**	EA

Figure A1.1 – Map of local industrial sources of Ni including modelled sources and sources that were not modelled (just mapped). The locations of the Sheffield Tinsley and Sheffield Devonshire Green monitoring stations are also marked.



A1.2. Modelling approach

ADMS v5.2.1 was used for the current modelling study. Detailed source characteristics for the release points summarised in Table A1.3 were derived from data received from the EA, the PCM and the previous 2014, 2016, 2018 and 2019 modelling studies as discussed in Section A1.1.

Model input datasets including terrain and meteorology are briefly described below. Table A1.4 summarises generic modelling parameters applied for each model run.

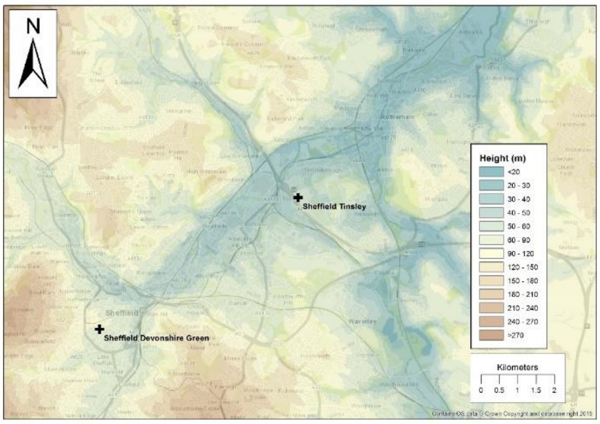
Table A1.4 – Generic modelling parameters

Variable	Parameters
Complex terrain	Y
Terrain grid resolution setting	64x64
Surface roughness at dispersion site	1.0 m[11]
Minimum Monin-Obukhov Length (LMO) at dispersion site	30 m[12]
Surface roughness at met site	0.05 m[13]
Minimum Monin-Obukhov Length (LMO) at met site	20 m[14]
Model output grid resolution	50 m

A1.2.1. Terrain

To treat the effects of terrain on dispersion detailed local terrain data based on OS Terrain 50 was incorporated (see Figure A1.2).

Figure A1.2 - Detailed local terrain based on OS Terrain 50



[11] ADMS recommended value for cities, woodlands
[12] ADMS recommended value for cities and large towns
[13] ADMS recommended value for airports
[14] ADMS recommended value for airports

A1.2.2. Meteorology

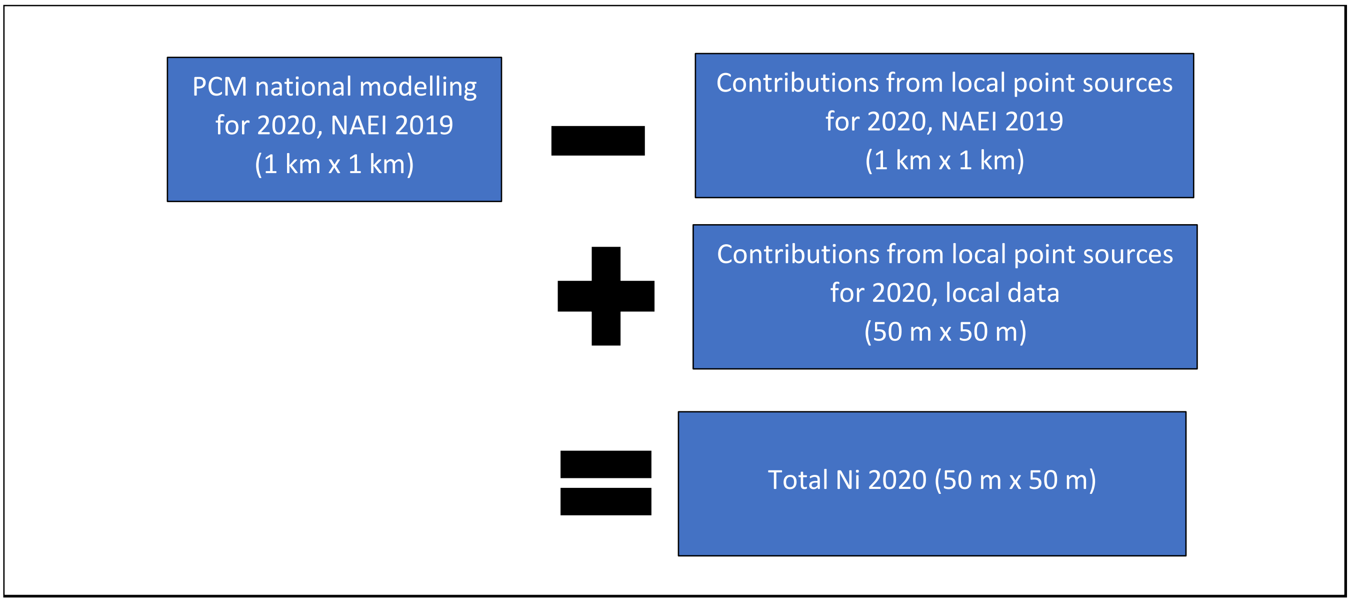
The meteorological outputs of the Weather Research and Forecasting Model (WRF) for Sheffield were used for the dispersion modelling. The WRF model is a next-generation numerical weather prediction modelling system developed by the US National Centre for Atmospheric Science (NCAR). This method accounts for spatial variation in meteorological parameters across the UK representing local dispersion characteristics. The outputs of the WRF model, including atmospheric boundary layer height, were fed to the ADMS meteorological pre-processor to be used for estimating the dispersion characteristics. The ADMS pre-processor requires the input meteorological data such as boundary layer height to be more than 40 m in height. In order to minimise the rejected meteorological lines by ADMS, the ADMS pre-processor was used to overwrite the WRF dataset that did not satisfy the required input conditions.

A1.2.3. Combining model data

As noted in Section A1.1.1. Review of sources present in the NAEI and national modelling, information on Ni emissions and release characteristics for the principal industrial Ni emission sources were provided by the Environment Agency and complemented by emissions data from the NAEI 2019.

Figure A1.3 shows how different modelled contributions have been combined. Within the results (Section A1.3) the combined output is referred to as Ni 2020b.

Figure A1.3 – Schematic of process to combine modelled contributions



A1.3. Model results

The results from the modelling study are presented in terms of concentration maps including a review of compliance impacts within the study domain (Section A1.3.1), and source apportionment in comparison to observations (Section A1.3.2).

A1.3.1. Concentration maps and compliance impact

Figure A1.4 presents the modelled total 2020 annual mean Ni concentration map for the Sheffield area from this study. The footprint of the modelled exceedance does not extend to the location of the Sheffield Tinsley monitoring station.

The area of exceedance of the Ni TV (20 ng mg^{-3}) is South of Sheffield Tinsley monitoring station in the vicinity of the Outokumpu site. An inspection of the area of modelled exceedance compared to 1 km gridded population (2011 census, scaled to 2019) indicates population exposure from the area surrounding Outokumpu in the south to Bawtry Road in the north. The model results also show the area of exceedance extends across the zone boundary to the south of Outokumpu into the neighbouring Yorkshire and Humberside non-agglomeration zone (UK0034).

A1.3.2. Source apportionment

Figure A1.6 shows the modelled Ni contribution from different sources at Sheffield monitoring site locations based upon the combined modelling output for 2020 (Ni 2020b). Measured concentrations at the sites are also presented, giving an indication of the level of agreement between modelled and measured concentrations. It is notable that the Outokumpu site remains the main industrial source of Ni at both the Sheffield Tinsley and Sheffield Devonshire Green monitoring stations.

With no scaling applied to the other background contributions from the national modelling, a small difference remains. The combined modelling output represents 98% of the observed concentration at Sheffield Tinsley, and there is a 4% over representation of the observed concentration at Sheffield Devonshire Green.

Figure A1.4 – Map of total annual mean Ni concentrations for 2020 from local fine-scale modelling of industrial sources based on reported (a) or derived (b) emissions, plus scaled contributions from uncertain local point/fugitive/diffuse sources (c) added to the background Ni concentrations from the national model.

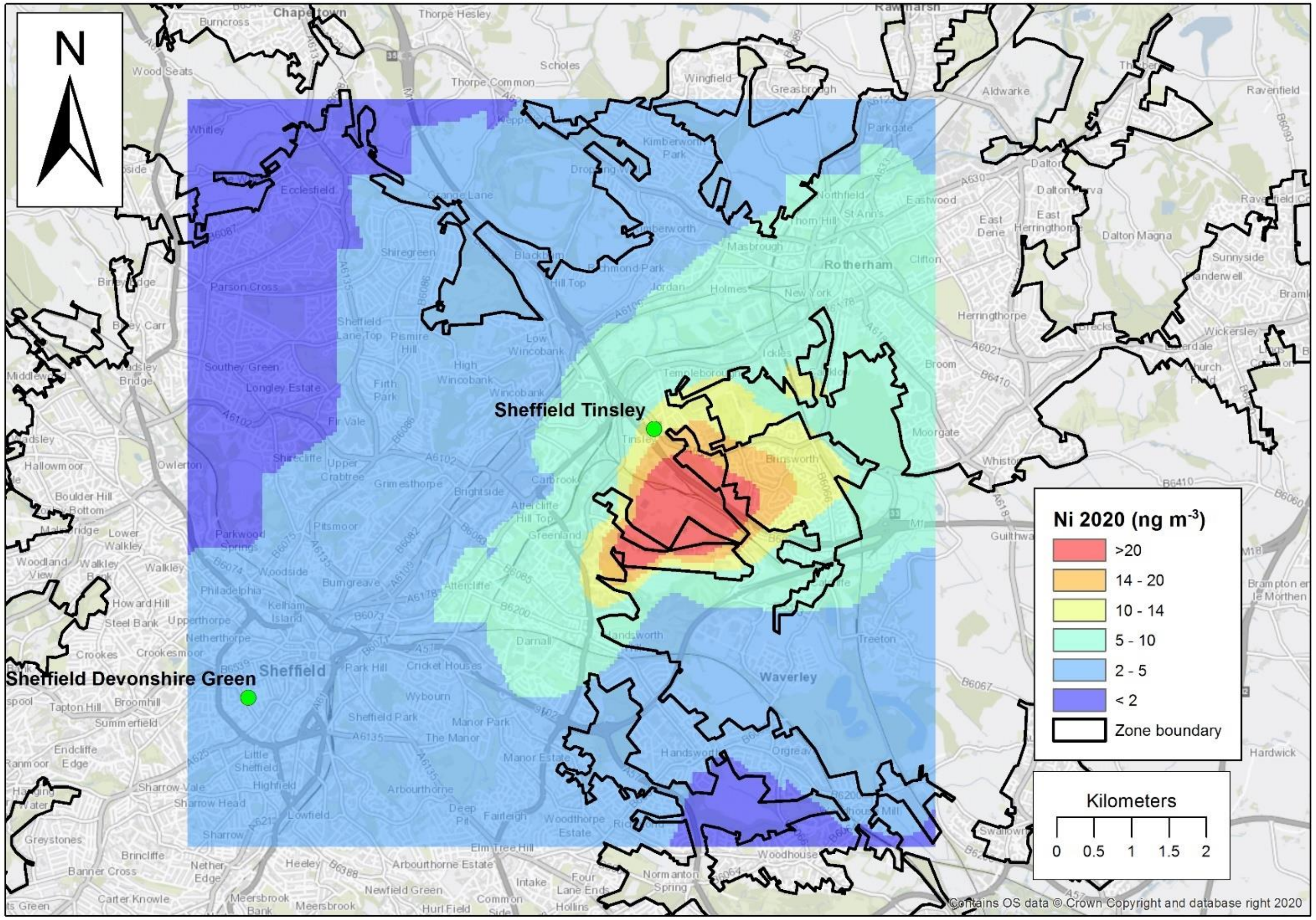
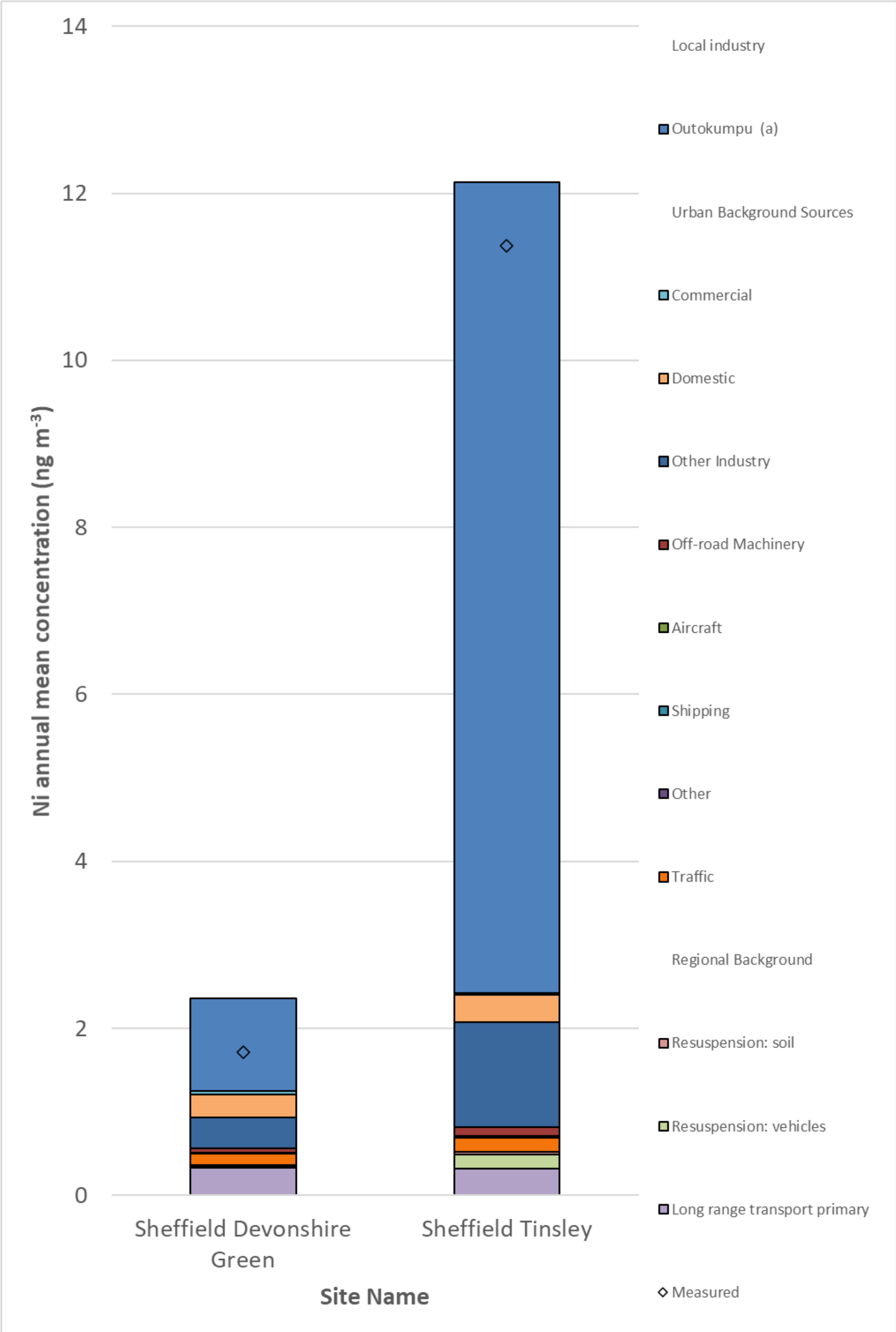


Figure A1.5 - Annual mean Ni source apportionment at Sheffield monitoring sites in 2020 (combined detailed and national modelling output)



A1.4. Conclusions

Based upon the results of the detailed modelling study present here:

- The detailed modelling indicates exceedances of the Ni TV (20 ng mg^{-3}) associated predominately with the Outokumpu site for the 2020 annual mean.
- The footprint of the modelled exceedance includes the Sheffield Tinsley monitoring station and inspection of the area of modelled exceedance compared to 1 km gridded population indicates population exposure from the area surrounding Outokumpu in the South to Bawtry Road to the North. The model results also show the area of exceedance extends across the zone boundary to the South of Outokumpu into the neighbouring Yorkshire and Humberside non-agglomeration zone (UK0034).
- The source apportionment analysis suggests that the main industrial source of Ni at both the Sheffield Tinsley and Sheffield Devonshire Green monitoring stations is Outokumpu.
- The combined modelling output represents 98% of the observed concentration at Sheffield Tinsley, and there is a 4% over representation of the observed concentration at Sheffield Devonshire Green.

Recommendations:

- A proportion of the total Ni concentration modelled in this study has been derived by scaling contributions from uncertain diffuse emissions from the stockyards of the Outokumpu facility. There is scope for further improving understanding of the emissions, activity levels and timing of operations identified in KCL study[10] and the EA/SCC/RMBC 2018 project[6] which would focus attention on the main Ni emitters and provide information for modelling studies. Discussions with the regulator have also revealed further potential sources within the site boundary, such as emissions as the result of transfer and storage of filter cakes to a landfill site close to the plant, or the storage of the extracted fume dust in the stockyards, that could potentially be accounted for in the future investigations.
- The high temporal resolution monitoring conducted by NPL and KCL has been valuable in that it enables directional analysis and informs source apportionment. Should work be needed to interpret future exceedances or to analyse the impact of measures such monitoring campaigns would be recommended.
- The national modelling for compliance assessment does not capture the observed exceedance because not all of the sources identified in this study are fully captured by the NAEI. Data gathered in this study and resulting from measures to quantify and reduce emissions from industry in Sheffield, could be used to inform future modelling and compliance assessments.